

REMARKS

Applicants thank the Examiner for the thorough consideration given the present application.

Status of the Claims

Claims 1, 3-24, 35 and 36 are now present in this application. Claim 1 is independent.

Claim 1 has been amended and claims 32-34 have been canceled. No new matter has been added since claim 1 incorporates textual subject taken from cancelled claim 34. Support may also be found at page 21, lines 16-18 of the present specification. Reconsideration of this application, as amended, is respectfully requested.

Examiner Interview

Applicants wish to thank the Examiner for the courtesies extended to Applicants' representative during the personal interview which was conducted on April 15, 2010. An Examiner Interview Summary has been made of record, and Applicants agree with the substance of the Interview Summary Form. The claims have been amended to place the claims in compliance with 35 U.S.C. 112, 2nd paragraph, and are believed to place the application into condition for allowance. Accordingly, reconsideration and allowance of the present application are respectfully requested.

Information Disclosure Citation

Applicants thank the Examiner for considering the reference(s) supplied with the Information Disclosure Statement filed December 7, 2009, and for providing Applicants with an initialed copy of the PTO-SB08 form filed therewith.

Drawings

Applicants thank the Examiner for indicating that the drawings are accepted.

Claim Objection

The Examiner has objected to claim 1 because of several informalities. In order to overcome this objection, Applicants have amended claim 1 in order to correct the deficiencies pointed out by the Examiner. Reconsideration and withdrawal of this objection are respectfully requested.

Rejection Under 35 U.S.C. § 112, 1st Paragraph

Claim 1 stands rejected under 35 U.S.C. § 112, 1st Paragraph. This rejection is respectfully traversed.

The Examiner states that the specification does not describe the droplets being dried during flight. Applicants have amended the claims to recite the droplets are dried to a solidified substance after landing on the substrate.

Applicants respectfully submit that the claims, as amended, comply with the enablement and written description requirements of 35 U.S.C. § 112, 1st paragraph. Accordingly, reconsideration and withdrawal of this rejection are respectfully requested.

Rejection under 35 U.S.C. § 102(b)

Claims 1, 32, 35 and 36 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Uchiyama. This rejection is respectfully traversed.

A complete discussion of the Examiner's rejection is set forth in the Office Action, and is not being repeated here.

As discussed at the interview, Uchiyama discloses a nozzle 20 ejecting droplets passing through an electrode 21. The purpose of the invention is to prevent secondary dots 26a that detract from the quality of the printed image. Uchiyama does not disclose the stacking of droplets. As stated in the Advisory Action dated May 21, 2010, this rejection has been withdrawn. Accordingly, reconsideration and withdrawal of this objection are respectfully requested.

Rejections under 35 U.S.C. § 103(a)

Claims 1, 3-6, 8-13, 23, 24 and 35 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Danforth in view of Sachs et al. Further, claims 7, 14-22 and 32 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Danforth in view of Sachs et al. and Hayes and claims 32-34 and 36 stand under 35 U.S.C. § 103(a) as being unpatentable over Danforth in view of Sachs et al. and Uchiyama. These rejections are respectfully traversed.

Complete discussions of the Examiner's rejections are set forth in the Office Action, and are not being repeated here.

While not conceding the appropriateness of the Examiner's rejection, but merely to advance prosecution of the instant application, Applicants respectfully submit that independent claim 1 has been amended to incorporate subject matter taken from claim 34 to recite a combination of steps in a method of producing a three-dimensional structure including the steps of providing a needle-shaped nozzle body having a fine inside diameter at a tip thereof, the nozzle supplied with a fluid, arranging a tip of the nozzle to be close to a substrate, ejecting a fluid droplet having an ultra-fine diameter from the tip of the nozzle toward a surface of the substrate by applying a voltage having a prescribed waveform to the needle-shaped nozzle body via the electrode so as to make the droplet fly and land on the substrate, and thereby the droplet being dried to be a solidified substance after landing on the substrate and continually ejecting subsequent droplets by applying the prescribed waveform voltage to the nozzle for the droplets being stacked on said solidified substance so as to form a grown three-dimensional structure, wherein the nozzle inside diameter is 0.01 μm to 8 μm .

Applicants respectfully submit that this combination of elements as set forth in independent claim 1 is not disclosed or made obvious by the prior art of record, including Danforth, Sachs et al., Hayes et al. and Uchiyama.

The size of the nozzle is an important part of the claimed invention, as stated on page 21, lines 16-18 of the specification. "Furthermore, to more effectively use the effect of a focused electric field, it is particularly preferable that the inside diameter of the tip of the nozzle is from 0.01 μm to 8 μm ." The focused electric field solves several difficulties, discussed below, and the droplets are stacked up spontaneously, a result that was unexpected to the inventor. The

specification discusses the difficulties encountered in the prior art on page 2, lines 10-25 which state:

<Difficulties in Ejection of an Ultra-Fine Droplet>

Currently, in an inkjet system (piezo system or thermal system) that is practically and popularly used, a minute amount of liquid such as smaller than 1 μ l can hardly be ejected. This is because the pressure required for ejection increases as the diameter of the nozzle decreases to be finer.

<Luck of Landing Accuracy>

Kinetic energy given to a droplet ejected from a nozzle decreases in proportion to the cube of the droplet radius. For this reason, a fine droplet cannot possess kinetic energy that is sufficient to withstand air resistance, and accurate landing cannot be expected, because of air convection or the like. In addition, as the droplet becomes fine, the effect of surface tension increases, which makes the vapor pressure of the droplet become high, and drastically increases the amount of evaporation (In this invention, unless otherwise particularly specified, "evaporation" includes meaning of volatilization). With this being the case, the mass of the flying fine droplet is considerably lost and even the shape of the droplet can hardly be kept in landing. (emphasis added)

Also page 11, line 17 to page 12, line 17 states:

In the method of producing a three-dimensional structure according to the present invention, ultra-fine droplets are discharged using ultra-fine inkjet. The ultra-fine droplets are evaporated extremely quickly by the influence of surface tension and the magnitude of a specific surface area. Hence, by controlling the drying and solidifying of the droplet (in the present invention, unless otherwise specified, the terms of drying and solidifying means that the liquid drops are evaporated and dried, thereby being increased in viscosity at least to a level such that the droplets can be stacked up), impact energy, focusing of electric field, and the like at appropriate levels, it is possible to form a three-dimensional structure having height. Hereinafter, these points will be described in more detail.

(Accurate Landing of Droplet with Focusing Electric Field)

In the method of producing a three-dimensional structure according to the present invention, stress toward the tip of a needle-shaped fluid discharging body (hereinafter also referred to as "nozzle") is continuously applied to the top of a structure formed by droplets that have been previously landed to a substrate (hereinafter also referred to as "previously landed droplets") and that have been solidified, in virtue of an effect of an electric field applied to an ultra-fine inkjet. Accordingly, once a structure starts growing, an electric field to be described later in FIG. 5 can be focused on the top of the structure. For this reason, an ejected droplet can be reliably and accurately landed on the top of the structure formed by the droplets having attached in advance.

Furthermore, the structure can be grown in the direction of the nozzle while it is always pulled by the above-mentioned effect produced by the electric field, and hence even if the structure has a high aspect ratio the structure can be formed without falling. These effects can efficiently promote the growth of a three-dimensional structure. (emphasis added)

The Examiner refers to column 25, lines 45-55 of Danforth as disclosing the use of droplets from a print head. However, Danforth discloses a “piezo activating pulse” for ejection which differs from the presently claimed method utilizing voltage pulse for ejection. Danforth uses a “thermoplastic material” (col. 25, lines 45) to build a structured fabrication. That is, this is one of the conventional technologies, but distinctly different from the present invention to use the mechanism of a drying-solidifying manner to build a 3D-structure.

Sachs et al. discloses a print head structure having a linear array of eight 50 micron diameter nozzles with 100 microns between nozzles. (See column 4, lines 61-64). Such a clear disclosure prevents any assertion that Sachs et al. can be used to support a rejection of a claim reciting a nozzle having a diameter of 0.01 μm to 8 μm .

The Examiner states that Hayes discloses the formation of droplets having a diameter of 3 μm or less, referring to column 8, lines 15-25. However, Hayes discloses “droplets on the order of 50 μm and smaller, making this disclosure similar to Sachs et al. Moreover, Hayes discloses the deposition of solder, and there has been no reasoning provided why this disclosure can be applied to modify a method using ink, such as disclosed by Danforth.

Uchiyama employs a pressure pump 22 for ejecting a liquid stream, not droplets. A piezo element (oscillator) 24 is equipped at the nozzle tip to provide vibration. Consequently, the wavelength of the vibrated liquid stream is gradually decreased by the effect of the surface tension of the liquid. Finally, each droplet is shared one by one as shown in the hand-writing drawing.

Uchiyama's nozzle head has inner electrode 27 and outer electrodes 30, 31, 32. However, these electrodes do not work for ejecting the liquid stream, but rather control the route of the stream. Uchiyama uses a controlling system to change the flying route of the stream by electrically charging the liquid, to guide the wasted ink toward a waste tank 35 via a suction pipe 34.

One of ordinary skill would never use a nozzle tip having a 0.01-8 μm diameter, much less stacking up the dried droplets by means of the effect of the focused electric field at the nozzle end with the method disclosed by Uchiyama.

Applicants respectfully submit that the combination of elements as set forth in independent claim 1 is not disclosed or made obvious by the prior art of record, including Danforth, Sachs et al., Hayes and Uchiyama, for the reasons explained above. Accordingly, reconsideration and withdrawal of this rejection are respectfully requested.

Conclusion

All of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. Applicants therefore respectfully request that the Examiner reconsider all presently outstanding rejections and that they be withdrawn. It is believed that a full and complete response has been made to the outstanding Office Action, and as such, the present application is in condition for allowance.


In view of the above amendment, Applicants believe the pending application is in condition for allowance.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Christopher J. McDonald, Registration No. 41,533, at the telephone number of the undersigned below to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Director is hereby authorized in this, concurrent, and future replies to charge any fees required during the pendency of the above-identified application or credit any overpayment to Deposit Account No. 02-2448.

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Respectfully submitted,

By  #42874

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